WETLAND SOILS AND HYDROLOGY

Acknowledgments

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Jim Ray, Indiana DNR, Wetlands Outreach Project Coordinator
Dave Stratman, Natural Resources Conservation Service
Merry Lea Environmental Learning Center of Goshen College
D.J. Case & Associates

The hue is listed in the upper right-hand corner of the chart page, the value is listed vertically and the chroma is listed horizontally. The name of the color is determined by the hue and the location of the color on the page. The hue is listed first, followed by the value and then the chroma. For example, on the enclosed chart page, the identified color is 10YR 3/2. The predominant color of the soil is the matrix color. Spots of contrasting color are described as mottles.

Characteristics of Hydric Soils:
Some indicators of hydric soils are listed as follows:

- A low chroma soil color (chroma of 1 with no mottles and chroma of 2 with distinct mottles) immediately below the A horizon or at 10 inches
- Sulfidic (rotten egg) odor
- Aquic moisture regime
- Histic epipedon (surface horizon is organic in nature)
- Iron or manganese concretions
- Hydric soil listing (either local or national)
- Histosol
- High organic matter content in the surface layer of sandy soils
- Streaking of organic matter in sandy soils

More detailed information regarding hydric soils can be found in "Field Indicators of Hydric Soils of the United States" (USDA NRCS – Wetland Science Institute and Soils Division).

Tools for Soil Surveying:
In order to conduct a field survey of the soils in the wetland, you will need a shovel or soil probe, a Munsell Soil Color Chart, and notes that were taken during the map review.

FIELD SURVEY INSTRUCTIONS

A field survey for soils can be conducted at any time of year, except when the ground is frozen. The best times to survey are when the soil is not flooded, there is no snow, and the soil is not frozen.

Step 1: Determine the mapped soil type for the area

- Use the soil survey to pin-point the soil type(s) for the wetland. Record this information in column IV (Mapped Type) of Table 1 (Soil Series) of the Survey Form.
- Bring a copy of typical soil profile colors and descriptions to the field.

Step 2: Dig Soil Examination Pit

- Place a labeled field stake at each soil sample location, pick a minimum of two locations per soil type.
- Remove loose leaf matter, bark, and other plant parts (duff) from soil surface.
- With shovel or probe, dig an approximately 20" deep pit. With shovel, pit can be width of shovel.
- Cut and lay section of profile on ground to examine each layer.

- Inundation
- Saturation of the soil within 12" of the soil surface
- Water marks (staining due to water on woody vegetation or fixed objects)
- Sediment deposits (vertical objects, including plants that have thin layers or coatings of sediment on them after inundation)
- Drainage patterns (evidence of drainage flow into or through an area, primarily in wetlands adjacent to streams)
- Drift lines (deposition of debris in a line on the surface or tangled debris indicating flooding)

The occurrence of one of these characters indicates the presence of wetland hydrology. The following are secondary indicators of wetland hydrology. Two of these characters must be identified to indicate wetland hydrology.

- Oxidized root channels (the presence of oxidized iron in root channels around live roots)
- Water-stained leaves
- Local soil survey data (depth to seasonal high water table information listed on "Engineering Properties of Soils" table in NRCS Soil Survey book)
- FAC-neutral test (are greater than 50% of the vegetation species wet, not including FAC (+/-) species)
- Other (morphological adaptations of plants, stream gauge data, etc.)

FIELD SURVEY INSTRUCTIONS

Step 1: Determine the presence or absence of wetland hydrology

- Note the presence of standing water (if any) in column II (Depth of Water) of Table 3 (Hydrology).
- While digging the soil pit, note the depth to free-standing water in the pit (if any). Record this observation in column IV (Depth to Free Water) of Table 3.
- Also determine the depth to saturated soil (if saturation is present) and record this information in column III (Depth to Saturation) of Table 3.
- If neither free water nor saturation is present, look for other primary or secondary characteristics. Record these observations under Additional Observations following Table 3.
- If characteristics (primary or secondary) are not present and the soil was hydric, look for indicators of adjacent drainage. If present, note these observations following Table 3.
- If indicators of hydrology are not present, the area may not be a wetland.
- Note physical alterations to the site, which may affect hydrology (i.e. ditching).

Step 2: To document hydrologic conditions, installation of monitoring wells (piezometers)

- Construct piezometer (see enclosed diagram of piezometer)
- Install at depth of 2' (see enclosed installation directions)
- Take readings with steel tape marked with a waterproof marker
- Readings should be recorded weekly and then daily when water is within 12 inches of the soil surface to determine the presence or absence of wetland hydrology.

Station #

I. Depth (inches)	II. Matrix Color	III. Mottle Colors	IV. Mapped Type	V. Observations Confirm Mapped Type? (yes/no)

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Station #

I. Depth (inches)	II. Matrix Color	III. Mottle Colors	IV. Mapped Type	V. Observations Confirm Mapped Type? (yes/no)

Table 2 - Soil Taxonomy:

I. Station Number	II. Soil Series	III. Soil Order	IV. Native Habitat	V. Observed Habitat

LIST OF RESOURCES

Books and Publications

US Department of Agriculture, Natural Resources Conservation Service. 1996. Field Indicators of Hydric Soils of the United States. G.W. Hurt, Whited, P.M. and Pringle, R.F (eds.). USDA, NRCS, Fort Worth, TX.
(can be obtained from the Wetland Science Institute, 301-497-5938
or online at http://www.statlab.iastate.edu/soils/hydric/fieldind/fieldind.html)

NRCS Soil Survey (per county), see attached list of offices

Munsell Soil Color Chart. MacBeth Division of Kollmorgen Instruments Corporation. (order from Ben Meadows or Forestry Suppliers)

Suppliers

Ben Meadows Company
Web site: www.benmeadows.com
Phone: 800-647-5368

Forestry Suppliers, Inc.
Web site: www.forestry-suppliers.com
Phone: 800-241-6401

DIRECTORY OF INDIANA SOIL & WATER CONSERVATION DISTRICTS (SWCDs)

Adams County SWCD
210-2 East Monroe Street
Decatur, IN 46733-1702
Phone: 219-724-4124

Allen County SWCD
2010 Inwood Drive
Fort Wayne, IN 46815-7181
Phone: 219-422-3373

Bartholomew County SWCD
2314 State Street
Columbus, IN 47201-7345
Phone: 812-378-1282

Benton County SWCD
109 South Grant Street
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Fowler, IN 47944-1540
Phone: 765-884-1090

Blackford County SWCD
1301North High Street
Hartford City, IN 47348-1443
Phone: 765-348-1404

Boone County SWCD
801 West Pearl Street
Ste C
Lebanon, IN 46052-2345
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Brown County SWCD
PO Box 308
Nashville, IN 47448-0308
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Carroll County SWCD
1523 North US Highway 421
Ste 2
Delphi, IN 46923-9396
Phone: 765-564-4480

Cass County SWCD
906 West Broadway
Logansport, IN 46947-2978
Phone: 219-753-2546

Clark County SWCD
9608 Highway 62
Charlestown, IN 47111-9640
Phone: 812-256-6171

Clay County SWCD
955 West Craig Avenue
Brazil, IN 47834-9102
Phone: 812-448-1108

Clinton County SWCD
860 South Prairie Avenue
Ste 1
Frankfort, IN 46041-7439
Phone: 765-659-3971

Crawford County SWCD
306 Oak Hill Circle
PO Box 189
English, IN 47118-0189
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Box 434-A
Washington, IN 47501-9582
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10729 Randall Avenue
Ste 2
Aurora, IN 47001-9388
Phone: 812-926-0128

Decatur County SWCD
108 Smith Road
Greensburg, IN 47240-8295
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942 West 15th Street
Auburn, IN 46706-2031
Phone: 219-925-3066

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2904 North Granville Avenue
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New Albany, IN 47150-3601
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Phone: 765-793-3651

Franklin County SWCD
10165-B Oxford Pike
Brookville, IN 47012-9414
Phone: 765-647-5713

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315 East Jefferson Street
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Martin County SWCD
PO Box 34
203 Main Street
Shoals, IN 47581-0034
Phone: 812-247-2423

Miami County SWCD
1170 US 24 West
Peru, IN 46970-1767
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Monroe County SWCD
1931 Liberty Drive
Bloomington, IN 47403-5146
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Montgomery County SWCD
407 East Market Street
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Crawfordsville, IN 47933-1852
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Morgan County SWCD
1328 Morton Avenue
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Newton County SWCD
PO Box 440
213 East North Street
Morocco, IN 47963-0440
Phone: 219-285-6889

Noble County SWCD
100 East Park Drive
Albion, IN 46701-1478
Phone: 219-636-7682

Ohio County SWCD
c/o Dearborn County SWCD
10729 Randall Avenue
Ste 2
Aurora, IN 47001-9388
Phone: 812-926-0128

Orange County SWCD
573 SE Main Street
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Paoli, IN 47454-9720
Phone: 812-723-2979

Owen County SWCD
RR 5
Box 102
Spencer, IN 47460-9444
Phone: 812-829-2605

Parke County SWCD
RR 4
Box 291-F
Rockville, IN 47872-9271
Phone: 765-569-3551

Perry County SWCD
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Cannelton, IN 47520-1215
Phone: 812-547-4686

Pike County SWCD
2101 East Main Street
Petersburg, IN 47567-8870
Phone: 812-354-6728

Porter County SWCD
3001 Leonard Drive
Eastporte Tower Ste 104
Valparaiso, IN 46383-2732
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Posey County SWCD
1805 North Main Street
Mount Vernon, IN 47620-1209
Phone: 812-838-4176

Pulaski County SWCD
309 North West Street
Winamac, IN 46996-1210
Phone: 219-946-3243

Putnam County SWCD
64 North US Highway 231
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Greencastle, IN 46135-9263
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1981 South Industrial Park Road
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Installing Monitoring Wells/ Piezometers in Wetlands

PURPOSE: Wetland regulatory personnel frequently need quantitative information about shallow hydrologic regimes of wetlands and adjacent uplands. Monitoring wells and piezometers are some of the easiest instruments to use to determine depth of shallow water tables. Most of the literature on piezometers and monitoring wells, however, deals with installation to greater depths than needed for wetland regulatory purposes. This technical note describes methods of construction and installation of monitoring wells and piezometers placed at depths within and immediately below the soil profile using hand-held equipment.*

DIFFERENCE BETWEEN SHALLOW MONITORING WELLS AND PIEZOMETERS: Monitoring wells and piezometers are open pipes set in the ground. They passively allow water levels to rise and fall inside them. The difference between a monitoring well and a piezometer is where along the pipe water is allowed to enter (length of perforated area).

Shallow monitoring wells allow penetration of water through perforations along most of the length of the pipe below ground. Therefore, the water level in a monitoring well reflects the composite water pressure integrated over the long, perforated portion of the pipe. This kind of well sometimes is called an "open-sided well," "observation well," or a "perforated pipe."

Piezometers allow penetration of water only at the bottom of the pipe, either directly into the bottom or along a short length of perforation near the bottom. Consequently, the water level in a piezometer reflects the water pressure only at the bottom of the pipe. Piezometers are sometimes called "cased wells."

The difference between monitoring wells and piezometers is significant because monitoring wells generally extend through more than one water bearing layer and therefore cannot be used to detect perched water tables, whereas piezometers can. Water pressures in the soil vary in response to several factors, including depth, differential permeability of strata, and water flow. These different factors can be isolated and interpreted independently with groups of piezometers. These factors cannot be differentiated with a monitoring well because different water pressures are intercepted at many depths within the same instrument and cannot be sorted out.

SELECTING INSTRUMENTATION: Before installing instruments, it is vital to define study objectives to avoid gathering unnecessary or meaningless data.

To investigate when a free water surface is within the top foot or two of the soil, 2-ft deep monitoring wells are sufficient. Deeper instruments are not necessary and may yield misleading information if improperly chosen and situated.

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* The methods described herein do not apply to water-sampling studies. Researchers needing to sample water from wells should refer to U.S. Army Corps of Engineers Document EM 1110-7-1(FR): Monitor Well Installation at Hazardous and Toxic Waste Sites and ASTM D5092-90: Design and Installation of Ground Water Monitoring Wells in Aquifers.

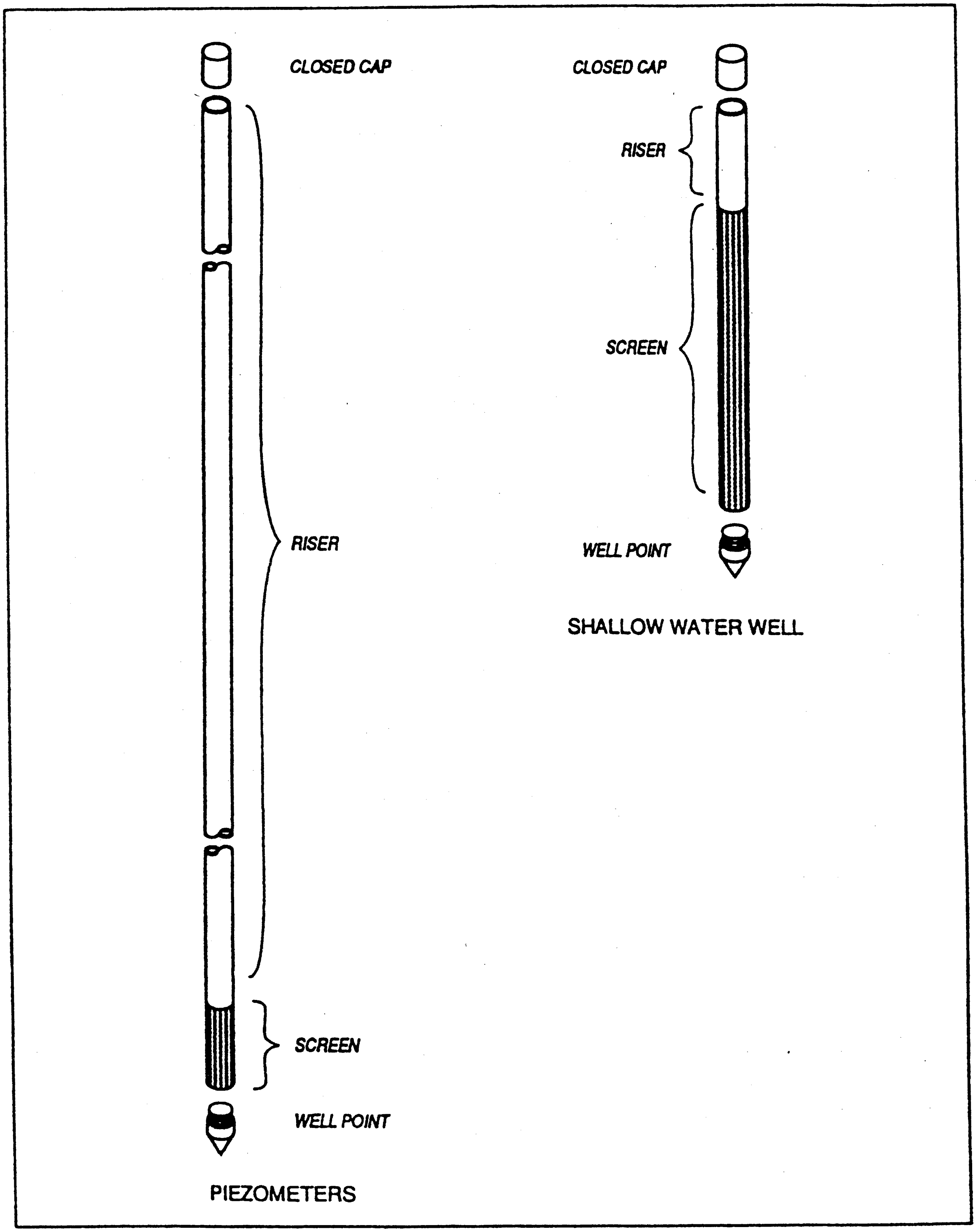

Figure 1. Parts of piezometers and shallow monitoring wells

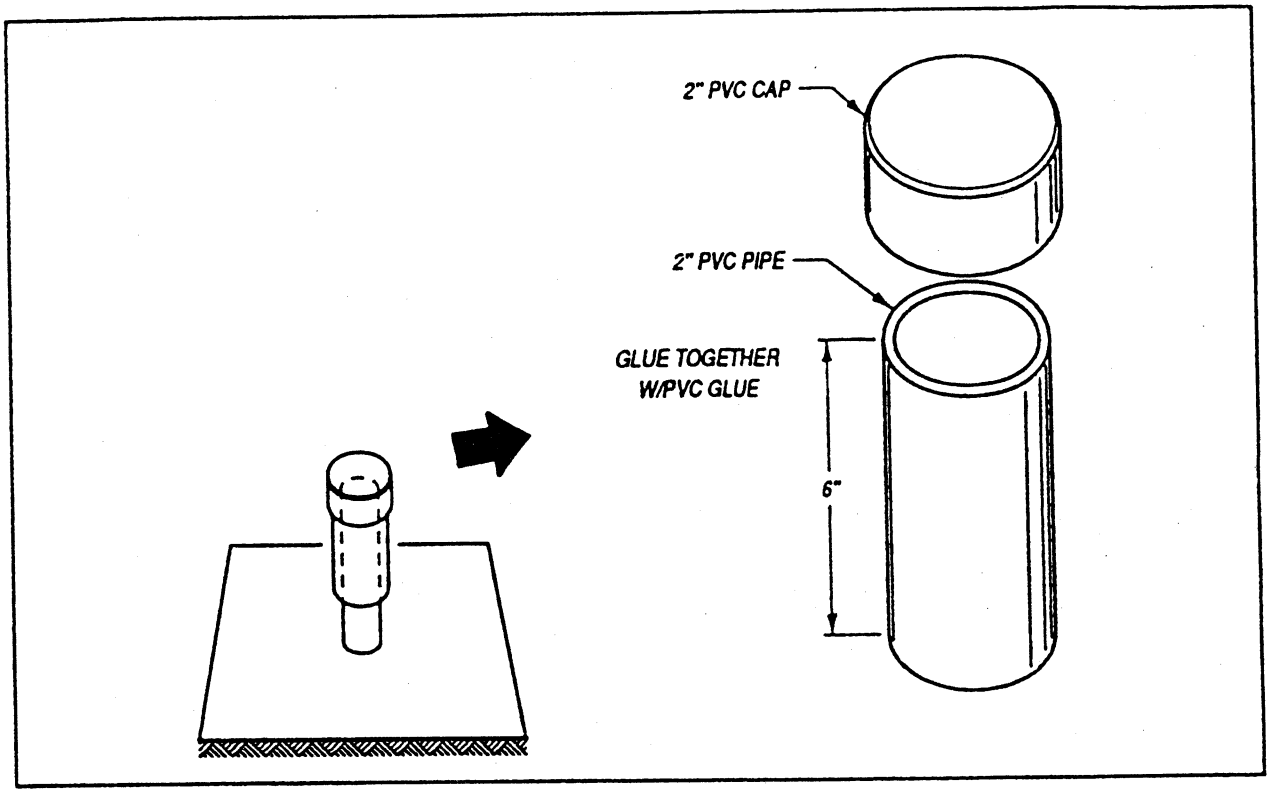

Figure 2. Homemade cap made of oversize PVC piping

dropped into a dry annular space it is necessary to drop water down, too, so the pellets can swell shut. The purpose of the bentonite collar is to prevent grout from flowing into the sand filter.

After the bentonite has been installed, grout is mixed and dropped down the remaining annular space up to the soil surface. The recipe for grout is 100 pounds of #2 Portland cement, 5 pounds of bentonite powder, and 7 gallons of water. The grout provides the primary protection from side flow down the riser because (1) it penetrates the surrounding soil matrix better than bentonite and (2) it does not crack during dry seasons.

- Sand is placed around the entry ports of the screen. Clean silica sand is commercially available from water-well supply houses in uniformly graded sizes. Sand that passes a 20 mesh screen and is retained by a 40 mesh screen (20-40 sand) can be successfully used with 0.010-in. well screen; finer sized 40-60 grade sand is appropriate for use with 0.006-in. screen. If available, the finer sand and screen should be used to pack instruments in dispersive soils with silt and fine silt loam textures.

  ASTM-5092-90 recommends that primary filter pack of known gradation be selected to have a 30% finer (d-30) grain size that is about 4 to 10 times greater than the 30% finer (d-30) grain size of the hydrologic unit being filtered. Use a number between four and six as the multiplier if the stratum is fine. This recommendation may not be achieved in clayey soils, in which case filter socks should be used.

- Filter socks are tubes of finely meshed fabric that can be slipped over the screened end of a well to filter out silt and clay particles that may be carried toward the pipe in flowing water. These constructed of 1-in. ID PVC pipe with threaded joints unless water sampling or automatic monitoring devices require wider pipe.

Installation: A shallow monitoring well should be installed by (1) auguring a 2.5-ft deep hole in the ground with a 3-in. bucket auger, (2) placing 6 in. of silica sand in the bottom of the hole, (3) inserting the well into the hole with the vented well-point into but not through the sand, (4) pouring and tamping more of the same sand in the annular space around the screen – this should be at least 6 in. below the ground surface, (5) pouring and wetting 2 in. of bentonite above the sand and (6) pouring grout to the ground surface. A final mound of grout prevents surface water from puddling around the pipe unless a concrete pad is required. Installation is illustrated in Figure 3.

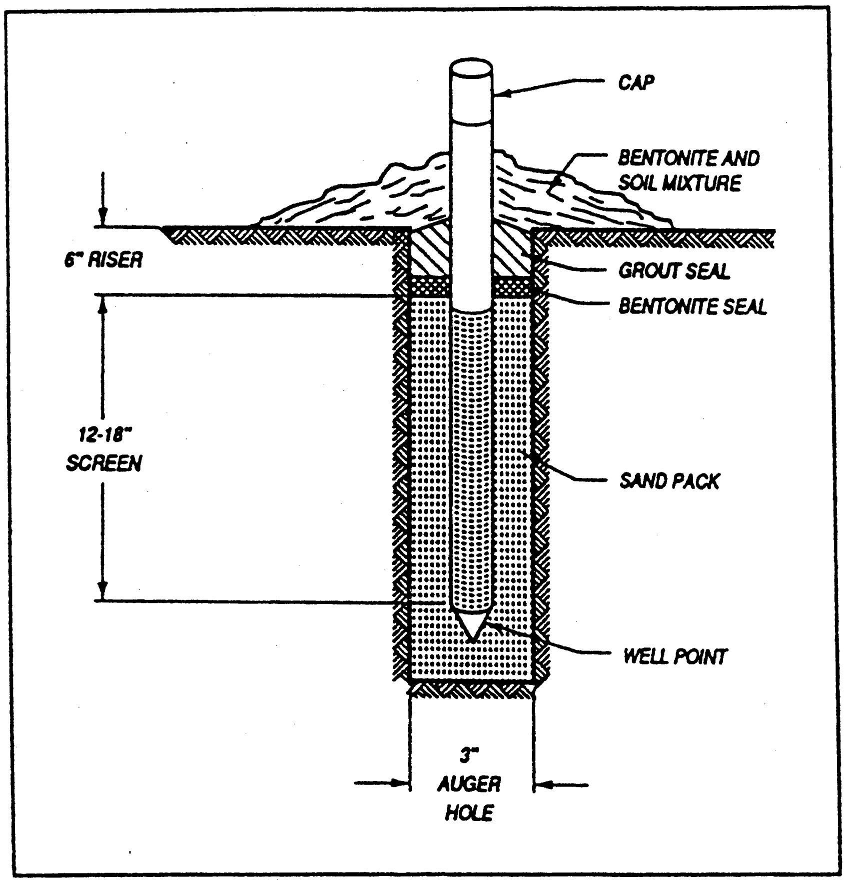

Figure 3. Shallow monitoring well

- Standard Piezometers. Installation method is for standard piezometers.

Uses: Standard piezometers are the preferred instrumentation for monitoring water tables. This method should be used whenever results may be published or litigated. Even in most jurisdictional studies involving shallow monitoring wells, a few standard piezometers should be installed around the project site to learn how deep the water table drops during the dry season.

Construction: Standard piezometers consist of 0.5-1.0 ft of screen, enough riser to extend above the ground, well cap, and vented well point. The total length of the piezometer will depend on the depth of the zone being monitored. Pipe diameter should be one inch unless sampling or monitoring instruments require wider pipe.

Installation: Installation of a standard piezometer entails (1) auguring a 3-in. diameter auger hole to a depth of 6 in. greater than the below-ground length of the piezometer; (2) dropping and tamping 6 in. of sand into the bottom of the augured hole; (3) inserting the well-point and pipe into the sand; (4) tamping sand around the length of the screen and 6 in. higher along the riser, (5a) if the sand filter is below the water table, pouring bentonite pellets into the annular space from the sand filter up to the water table, or (5b) if the sand filter is above the water table, pouring bentonite pellets at least 6 in. above the sand filter and wetting with water; and (6) pouring

- Checking for Plugged Pipes. After the pipe has been installed it is necessary to assure that it is not plugged. For pipes installed above the water table fill the pipe with water and monitor rate of outflow; for pipes installed below the water table pump the pipes dry and monitor rate of inflow. If the screens are plugged one should re-install the pipes. This test should be performed every few months throughout the study.

READING WATER LEVELS: Numerous methods have been devised for reading water levels in shallow piezometers and wells. The simplest method is to mark a steel tape with a water-soluble marker and insert the tape to the bottom of the well. The only equipment needed with this method is the tape, marker, and a rag to wipe the tape dry after reading.

Other methods involve use of various devices at the end of a flexible tape. All suffer from the lesser accuracy obtained with a flexible tape rather than a rigid one. Most also suffer from inconvenience or complexity. Some of the variations are: (1) floating bobs on the end of a flexible tape (these must be calibrated to correct for length of the float and for displacement of water); (2) electric circuits that are completed when a junction makes contact with water; and (3) devices that click or splash when a flexible tape is dropped down the well (there is always uncertainty about the exact depth at which the noise was heard).

Water levels may also be monitored continuously with down-well transducers and remote recording devices. These cost around a thousand dollars per well but may be necessary for some study objectives. Automatic recording devices may pose special limitations on pipe diameter or construction, so the recording instrumentation should be investigated before pipe is bought. Because automatic devices may be re-used in many studies, cost estimates should be prorated over their expected life rather than assigned only to one study. If study objectives require frequent readings at remote sites an automatic recording device may be the only option available.

One method of reading water levels that should be avoided is insertion of a dowel stick down the pipe. Dowels displace enough water to give significantly false readings, particularly if the pipe has a narrow diameter and the dowel is inserted the entire length of the pipe. A steel tape also displaces water, but not enough to cause significant error.

When reading water levels height of the riser above the ground surface should be noted. Monitoring wells and piezometers may move as much as 3 in. in a season in clayey soils that undergo wet/dry or freeze/thaw cycles.

Frequency of reading will depend on study purposes. When determining consecutive days with water tables at a particular depth for wetland delineation purposes, daily readings may be necessary once the "growing season" starts. Daily and even hourly readings may be necessary to monitor tidally influenced wetlands. Longer term studies are usually adequately served with biweekly readings during most of the year and weekly readings during periods of water-table rise or draw-down. Long breaks between readings may cause ephemeral fluctuations due to intense storms or floods to be missed. If the study is important enough to be published or litigated, readings should be frequent and regular.

SOURCES OF ERROR: The following are significant sources of error with piezometers and monitoring wells: (1) side-flow down the riser, (2) plugged screens, (3) movement of pipes due to shrink/swell and freeze/thaw cycles, (4) water displacement during reading, (5) infrequent readings, (6) incorrect instrumentation, (7) pipes of too large a diameter, (8) faulty caps, and (9) vandalism.

professionals with many other responsibilities to delay a trip to the field because of intruding obligations. Yet, gaps in a data set will call an entire study into question. If budgets allow, automatic recorders may solve the problem.

- Incorrect Instrumentation. Piezometers are preferable to shallow monitoring wells for most questions more complicated than simple presence or absence of water tables in the rooting zone. Water levels in monitoring wells are composites of the hydrologic head at all depths intercepted by the well screen. Consequently, perched water tables will usually be misinterpreted if monitoring wells penetrate the drier substratum beneath.

  Readings from improperly placed piezometers can also be misinterpreted. Piezometers should not be placed at uniform and arbitrary depths without reference to soil horizon differences. Piezometers placed at arbitrary depths are likely to straddle horizon boundaries or entirely miss highly permeable horizons with significant subsurface flow.

- Large-Diameter Wells. Piezometers and wells should be as narrow as practical. The wider the pipe, the greater the volume of water that has to move in and out of it in response to changes in hydraulic head. Consequently, a large-volume monitoring well will respond more sluggishly than a small-volume well. This is more critical in soils with low permeability and for studies that require monitoring several times a week or shortly after major precipitation events.

  Most wells can be successfully constructed from 1 or 1.25 in. pipe. Use of 4 or 6 in. pipe should be avoided unless study conditions require the larger pipe. An excessively large annular space should also be avoided, for the same reasons.

- Faulty Caps. Commercially manufactured caps often fit too tightly on PVC riser, necessitating excessive force to remove them. The resultant jostling can disrupt the seal between the pipe and the sealant, allowing water flow along the side of the pipe. To avoid this, threaded caps -- if used at all -- should be screwed on the pipe loosely. Avoid caps made of materials that deteriorate and break in sunlight or frost, can be nudged off by animals, or blown off in the wind. Most such problems can be alleviated by use of home-made caps constructed as described in Figure 2.

- Vandalism. Often vandalism cannot be avoided. Three approaches to the problem are (1) to hide the wells, (2) to shield them, and (3) to post them and request they not be disturbed. Simple signs stating "Ground-water pipes: please do not disturb" have been used successfully. In some communities it may be better to hide the pipes. Padlocks may keep out the curious. A second and larger pipe surrounding the above-ground portion of the monitoring well may offer protection against gunshot. Still, pipes probably cannot be protected from the malicious. Extra equipment should be bought at the beginning of a project so that vandalized wells can be replaced.

INTERPRETING RESULTS: As mentioned previously, data from shallow monitoring wells are ambiguous unless the well is very shallow (2 ft or less), or the soil is highly permeable or unstratified. A 4-ft deep well that traverses a profile of A-E-Bt-C is likely to miss the slightly perched water table that rests on top of the Bt and in the E. The most permeable horizon contributes the most water to a water well. If the bottom of the well intercepts an unsaturated horizon of higher permeability, then water can actually be wicked away from the well.

Piezometric data can also be confusing unless one is familiar with principles of water flow. If water is static in unstratified soil, water levels in all piezometers should be the same (Fig. 5). However, if

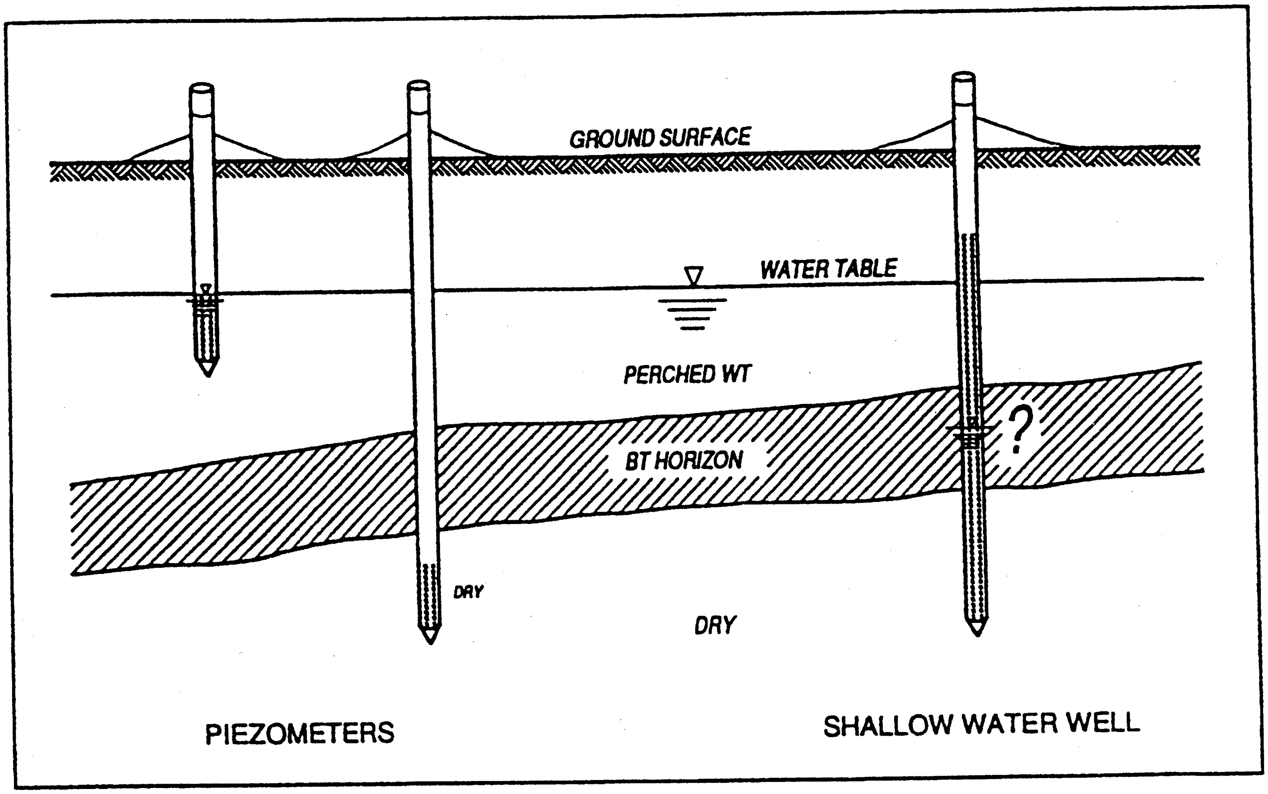

Figure 6. Monitoring instruments in stratified materials with perched water-table

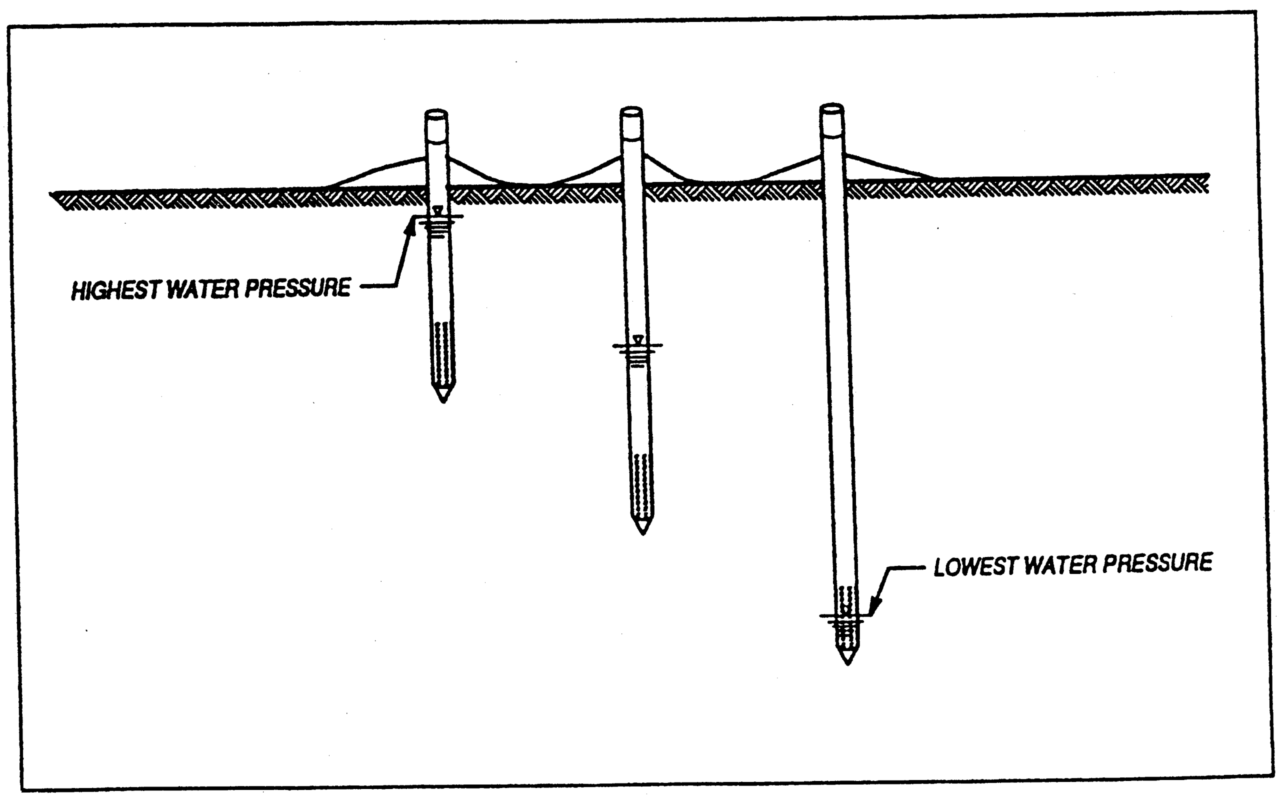

Figure 7. Recharge system with water flowing downward